IBERO-AMERICAN SYMPOSIUM ON PROJECT APPROACHES IN ENGINEERING EDUCATION

A First Year and First Semester Project-Led Engineering Education Approach

Diana Mesquita[*], Anabela Alves[*], Sandra Fernandes[*], Francisco Moreira[*], Rui M. Lima[*]

[*] Production and Systems Department, School of Engineering, University of Minho, Campus of Azurém, 4800-058 Guimarães, Portugal

Email: diana@dps.uminho.pt, anabela@dps.uminho.pt, sandra@dps.uminho.pt, fmoreira@dps.uminho.pt, rml@dps.uminho.pt

Abstract

This paper describes the organization model of a Project-Led Education (PLE) process carried out in the Industrial Management and Engineering (IME) programme at the University of Minho. It intends to analyse the PLE approach in the first year and first semester, according to the perceptions of the coordination team involved in the 2008/09 PLE edition. The emerging data from a group discussion with all coordination team members revealed a set of dimensions which allow a better understanding of the way the process is organized and how it could be improved. The constraints found were mainly three: first, teachers feel that in this process they have much more work than in traditional methodologies; second, some aspects of lack of suitable interdisciplinarity between subjects were identified; and finally some doubts in regard to learning outcomes were raised and some suggestions of individual activities were proposed. Therefore, a set of improvement changes will be presented in order to overcome some of the difficulties identified by faculty staff. These changes will be taken in account in the design of the next PLE edition (2009/10).

Keywords: interdisciplinary project approaches; engineering education; faculty staff perceptions.

1 Introduction

The current demands of the Bologna Process represent a change represent a process of change in curriculum design, as programs and course structures need to be revised and new teaching methods adopted, in order to focus learning on students. In the context of Engineering Education, Mills & Treagust (2003) have identified a set of critical issues that need to be addressed for significant changes in Engineering Education. These authors call attention to the following concerns:

- Engineering curricula are too focused on engineering science and technical courses without providing sufficient integration of these topics or relating them to industrial practice. Programs are content driven.
- Current programs do not provide sufficient design experiences to students.
- Graduates still lack communication skills and teamwork experience and programs need to incorporate more opportunities for students to develop these.
- Programs need to develop more awareness amongst students of the social, environmental, economic and legal issues that are part of the reality of modern engineering practice.
- Existing faculty lack practical experience, hence are not able to adequately relate theory to practice or provide design experiences. Present promotion systems reward research activities and not practical experience or teaching expertise.
- The existing teaching and learning strategies or culture in engineering programs is outdated and needs to become more student-centred. (Mills & Treagust, 2003:3)

Therefore, new educational methods and strategies are needed in order to engage students in the learning process and guarantee higher quality at undergraduate programs. Project-Led Education (PLE), for instance, is a teaching and learning approach which takes in account student-centred learning.

Motivated by this need for change, a group of teachers from the Production and Systems Department at the University of Minho has implemented a Project-Led Education (PLE) methodology in the Industrial Management and Engineering (IME) Masters Degree, during the past 5 years. Project-Led Education emphasizes team work, problem-solving and articulation between theory and practice by carrying out a project, based on a real situation linked with the students' future professional context, which culminates with the presentation of a solution /

product (Powell & Weenk, 2003). In Project-Led Education, students work together in teams to solve large-scale open-ended projects. The key features aim at fostering student-centeredness, teamwork, interdisciplinarity, linking theory to practice, development of critical thinking and competencies related to interpersonal communication and project management (de Graaff & Kolmos, 2003; Helle *et al*., 2006).

The PLE process implemented at the University of Minho, in the IME programme, involves teams of students from the first year and a coordination team composed by teachers, tutors and educational researchers. The project is developed during a semester and is based on project supporting courses (PSC).

This paper aims to describe the organization model of the Project-Led Education (PLE) process carried out in the first year and first semester of IME in 2008/09. An analysis of the coordination team perceptions and a set of improvements are also presented.

2 Organization Model

The characterization of PLE's organization model, presented in this paper, is based on the 2008/09 edition implemented in the first year of IME at University of Minho. The organization model description is structured according to the following aspects: stakeholders, i.e. students and faculty staff; courses; project.

2.1 Stakeholders

This project involved 38 students of first year of IME. Most of these students accessed to IME at University of Minho through national contest to higher education and a minority are transferred from other courses at the same university. Students who accessed by national contest have an average mark of 168.9, the minimum 158.4 and the maximum 188.0 (scale 0-200), and 29% of them entered in their first option. Their ages range between 18 and 23 years old. For the development of the project, the students were organized into 6 teams, varying from 5 to 7 members.

The coordination team of the first year, first semester 2008/09 included 12 members. Nine of these members are teachers that have different roles: 3 of them are lecturers and team tutors, 3 are only lecturers and finally 3 are only tutors. The coordination team also includes the course director and two educational researchers. There was an additional member, a teacher of a non supporting course that assisted to the all process and participated as an observer. Most of these members have been participating in different editions of this project and a large number of these also had training on Project-Led Education methodology.

2.2 Courses

The implementation of PLE in Integrated Master's Degree of (IME) is supported by the first four courses represented in Table 1. These are considered as project supporting courses (PSC) and the fifth course - Introduction to Economic Engineering (IEE) - in this table is a non-supporting course. The five courses of the semester represent a total of 30 ECTS (European Credits Transfer System), as indicated in Table 1.

Table 1: First year, first semester study plan of Industrial Management and Engineering.

Course	ECTS
Calculus C (CC)	6
Computers Programming I (CP1)	7
General Chemistry (GC)	5
Introduction to Industrial Engineering (IIE)	6
Introduction to Economic Engineering (IEE)	6

The Project was introduced as a value added to the learning process of the first year students. The technical competences acquired by the students come from specific courses' contents and from the interdisciplinary project. Additionally students develop transversal competences mainly through project activities: project management competences like time management and organization skills; team working competences such as responsibility, leadership and problem solving; writing and oral communication skills and, also, personal developing competences like critical thinking and creativity.

The linkage of interdisciplinary contents in an integrated way is supported by the Project. As the Figure 1 illustrates, each PSC had different contents included in the project, being CC, the course with minor participation. This means that some subject contents of each PSC was assessed by the contents included in the Project and specific contents not assessed in Project.

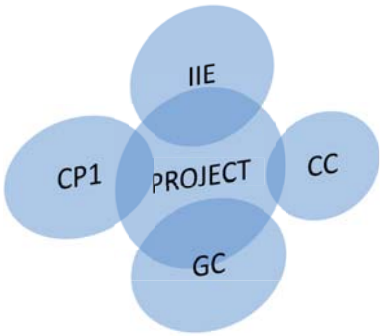

Figure 1: The four PSC involved in first year first semester IME PLE.

Student assessment in IME PLE courses is based on continuous assessment of the PSC specific contents and on project assessment. The final project grade has a 40% impact on students' final grade and continuous assessment 60%. Each PSC defines its own way of assessment based on small group tasks or work assignments and written tests. The criteria and the methods for the assessment of each PSC were, also, defined by the responsible teacher of each PSC. In the 2008/09 IME PLE edition, the number of assessment items (tasks and tests) defined by the teacher responsible for each PSC, is indicated in Table 2.

Table 2: Number of assessment items for PSCs.

PSC Assessment Item	PC1	IIE	GQ	CC
PSC Tests	4	2	2	2
PSC Tasks	1	6	2	3

2.3 Project 2008/09

This section describes the four main dimensions that are needed to understand the project carried out in the 2008/09 edition. These include the definition of the project theme, the start of the semester, the project process – since the beginning to the end and, finally, the assessment model.

2.3.1 Theme

Coordination team members are asked to freely suggest project themes at an early stage. Themes are then picked-up from the pool of ideas and subject to discussion during a coordination meeting. Themes are object of scrutiny by project supporting course (PSC) lecturers. This procedure contributes for validation of the eligibility and relevance of project contents within the context of each single PSC. A selected project theme normally emerges as a result of: a) adequacy to PSC contents (and vice-versa); b) coordination team members individual perceptions on the relevance of the project theme; and c) project holding adequate dimension for a full semester work by a team that can vary from 5 to 8 students. Therefore themes vary each year. After agreement on the project theme, all student teams work on such theme during the whole semester. The theme scope is normally wide enough to allow for significant diversity in both problem solving approaches and solutions.

The 2008-2009 first year first semester project intended to design and detail the: "Production of batteries for plug-in electric cars: specification of the battery system and the production system". The objectives of the project were:

1. Specification of the battery system for a plug-in electric car. This included: a) specification of relevant vehicle parameters; b) specification of the battery system: battery type, power, charge time, dimensions, weight, expected lifetime, environment impact, limitations of the chosen battery, etc., and c) electric vehicle autonomy.
2. Specification of the battery production system. This included: a) target market; b) monthly production; c) number of workers; d) suppliers; e) materials supply; f) Production management; g) equipments; h) layout; i) costs; j) proposals of eco-sustainable measures within the production system (such as rationalize de use of water, energy, materials, waste, etc.).

Teams were instructed to develop fully rigorous specifications. Their final work should show and prove the development of PSC-specific technical competencies. Students were informed of such PSC competencies in the beginning of the semester. The PLE approach intends to develop not only PSC-specific competencies but also soft skills, which are not well developed using traditional teaching approaches. Among these, there is a special emphasizes on teamwork skills; project management skills; communication skills and conflict management skills. The project development process also stimulates critical thinking and creativity while rewarding teams and individuals with initiative power.

Teams were introduced to the project theme by way of a short description on the relevance of cars for personal mobility, the global dependency on fossil fuels, the 2008 spotted energy crisis and consequent increase in fuels cost, the global phenomenon of climate change, and greenhouse gas emissions (GHG). Basic statistical data on Portuguese high dependency on energy imports (about 83%) were also given, showing the country's vulnerability to oil prices fluctuation. The Portuguese government holds a strategic agreement with Renault-Nissan group for the introduction of electric cars from 2011 onwards. This has set a high spotted relevance for electric cars thematic, and a renewed motivation to teams.

2.3.2 Start of the semester

For coordination team members the start of the semester begins two weeks before the start of classes. In the first meeting of the coordination team, everything has to be prepared: the session where the PLE project will be presented to students; PSC related issues, i.e. learning outcomes, week-by-week contents planning, assessment, etc.; the selection of the project theme, as described in section 2.3.1; detailed schedule of the first week of the PLE where student teams develop the pilot project, establish the project milestones and the evaluation system. Additionally, it is necessary to allocate some tasks: development of PLE supporting documents such as the students' project guide, the project description, the semester schedule, the first week plan and a short description of the pilot project and aims. Tasks allocation are discussed and agreed with all team members. Most coordination team members remain within the team year after year, except the Calculus C teacher. The first coordination team meeting usually includes a short balance on the previous year PLE run, in an attempt to refine the process.

The PLE presentation session is scheduled as the first event of the semester for the new students. This includes an introduction by the Course Director followed by the coordination team leader who presents PLE. This presentation launches the project theme, the overall project plan and the following PLE aspects: advantages and challenges of the PLE methodology; skills to develop in the course of the project; presentation of the members of the coordination team; tutor role; PSC classes plan; week schedule; monitoring project progress and milestones; assessment system. During this session the teams are formed and one tutor is allocated to each team. After the session, the students have the first meeting with the tutor. Each team is allocated a space (a permanent project room), a laptop computer, individual lockers and keys for the project room. Teams are afterwards instructed in teamwork and multimedia presentations. The teams then begin to develop the pilot project which they have to present in about a week time. The pilot project includes the construction of a Web Page (using a simple html editor) whose contents are the initial ideas and context for the project. This pilot project requires the development of many smaller tasks in a short timeframe. Therefore the teams have to organize themselves, split the tasks among team members, sequence them and assure that all runs smoothly to successfully accomplish the task. Therefore the pilot project works as a shortened experience of what will be the teams work during the full semester. At the end of week 2, the student teams have to come up with, and present, the project plan. At an early project development stage, teams have to be working and understanding the PLE methodology.

2.3.3 Process

The project plan has 19 weeks, with 9 to 17 hours of classes per week, one hour with tutor and 2 to 4 hours of additional support, in a total of 5 to 18 contact hours per week. The project schedule is presented in Figure 2. The figure also shows the 10 milestones of the project. After Christmas' holidays (week 14 and 15) there are no more classes and the teams concentrate their efforts in concluding the project work and some subject-related assessment activities.

Student-teacher hours	*Week 1*	*Week 2*	*Week 3*	*Week 4*	*Week 5*	*Week 6*	*Week 7*	*Week 8*	*Week 9*	*Week 10*	*Week 11*	*Week 12*	*Week 13*	*Week 14*	*Week 15*	*Week 16*	*Week 17*	*Week 18*	*Week 19*
Classes	4	17	17	17	17	17	17	17	17	17	13	13	17			<17	<17	<17	<17
Tutor	1	1	1	1	1	1	1	1	1	1	1	1	1			1	1	1	1
Total	5	18	18	18	18	18	18	18	18	18	14	14	18			<18	<18	<18	<18

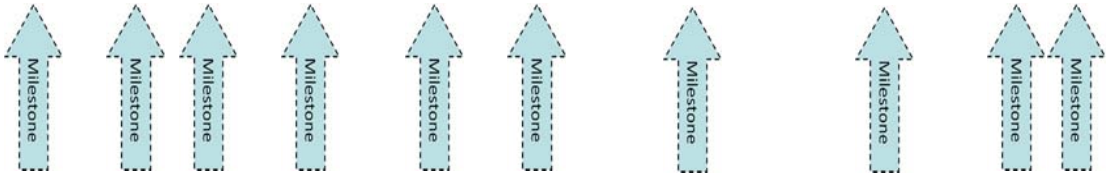

Figure 2: Project Aggregated Plan - classes' plan, tutor meetings and milestones

Project progress is monitored along the semester. Ten milestones enable the coordination team to acknowledge the team progress. In each milestone, teams are expected to deliver documents and/or presentations which are subject off scrutiny by some or all coordination team members. Teams underperforming are spotted and specifically tracked for project progress in following milestones. Table 3 presents all milestones, delivery times and expected deliverables.

Table 3: Milestones of the project.

Milestone	Date	Requisite
1	2008.10.02 2008.10.03 (Week 2)	18:00 – Pilot Project – Deliver a specification and a presentation file 14:10 – Pilot Project presentation
2	2008.10.10 (Week 3)	18:00 – Deliver a document (max. 2 pages) with the internal strategy to manage the team
3	2008.10.21 2008.10.22 (Week 5)	18:00 – First report delivery (max. 25 pages) 14:10 – Project progress presentation
4	2008.10.29 (Week 6)	14:10 – Extended tutorial
5	2008.11.18 2008.11.19 (Week 9)	18:00 – Intermediate report 14:10 – Formal presentation
6	2008.11.26 (Week 10)	14:10 – Extended tutorial
7	2008.12.19 (Week 13)	18:00 – Deliver a balance document (work done and future work)
8	2009.01.09 (Week 16)	18:00 – Preliminary version of the final report (max. 60 pages)
9	2009.01.23 (Week 18)	18:00 – Final report (max. 70 pages) + prototypes
10	2009.01.28 2009.01.29 (Week 19)	10:00 – Final exam (written test) 14:10 – Final presentation, discussion and poster delivery

On milestone 2, the team should deliver a document which describes the management strategy that the team will use to control the progress of the project. The coordination team uses that document to check if teams understand the meaning of team working and the eventual need to develop and explore strategies that will help bypass difficulties arising during the project. Extended tutorial – milestone 4 and 6 - is a special meeting, held twice in a semester, between each team and all the members of the coordination team. This meeting intends to give a more broad feedback on the work done by the team, and clarify any doubts relating the project that could persist within the team. The balance document – milestone 7 - helps teams to acknowledge their project status, i.e. what was already achieved and what remains to be done and when. The final exam - milestone 10 - is an individual exam on the respective project team contents. It is normally based on the project report delivered in milestone 9. This exam assesses the individual involvement and responsibility within each team. The project ends with a final presentation followed by discussion. The PLE has a final social activity which brings together students and teachers in an afternoon snack offered by the Course Director, to discard the stress accumulated during the semester.

A general model for engineering projects (Van den Kroonenberg, 1992) is included in the project guide. The model intends to aid the teams on identifying the project phase and serves as a general guideline for project phase contents, expected results and deadlines. The phases' description and expected deadlines are presented in the Table 4.

Table 4: Project phases, expected results and expected deadlines.

Phase	Expected Result	Expected Deadlines
Preliminary analysis	Context description; Problem definition; Objectives definition; Requisites identification and conditions.	Until week 2
Specification	Specifications; Alternatives list for the solution; Construction proposals.	Until week 8
Construction	Prototype, model, program construction.	Until week 12
Test/evaluation and e revision	Test, strengths and weaknesses identification and revision.	Until week 15
Implementation		Until week 19

2.3.4 Assessment

The IME PLE assessment has two major components: c_1 - continuous assessment of PSCs; c_2 - project assessment. The assessment weights of each component can vary yearly; in 2008/09 c_1 weighted 60% of the PSC final grade while c_2 weighted 40%, as previously referred. Early editions of IME PLE also used a 50/50 weight. The c_1 component includes work assignments and written tests. The c_2 component derives from the Project grade (team): Reports (60%), Prototypes (20%), Presentations and Final discussion (20%), which is transformed in an individual grade by multiplying the respective grade by: a) the peer assessment factor; and by the individual written test grade (20%). The assessment model was built in a way to help students regulate their own learning, however the authors identify that most project items are assessed only in a later phase of the project, although project related feedback is given extensively during the semester.

3 Coordination Team Perceptions

After completion of the IME based PLE semester, the coordination team members were asked to reflect on their experience. Few domains of analysis showed predominance over others. These domains included: staff workload; project theme and content integration; learning outcomes and the PLE methodology. In order to improve the IME PLE and students' learning outcomes, some of these aspects will be taken in account when preparing the next semester and will be discussed in the section 3.4.

3.1 Staff workload

From the discussion of coordination team members, the staff workload was one of the main concerns shared by most of the participants in PLE.

The single NSC teacher (IME PLE observer) stated "I never thought it would give so much work" and "You do not know the workload involved if you are not on it". She also referred to the high quantity of emails exchanged and the number of decisions that had to be taken.

The teacher of CC regrets that the respective course truly "awakened" to the PLE project in a later stage of the project. This teacher also indicates the "excessive PLE-related workload, both for students and teachers… especially in the final stage of the project", but he is positive about joining IME PLE next year and on the need for teacher stability to allow a successful contribution of the respective course on the IME PLE. He points out that the main advantage of the PLE is the integrated perspective that students acquire in regard to the PSC courses that make up a semester.

IIE teacher said that "it is possible to do the same with less effort" and that "…we need to be more efficient to reduce the coordination team workload". He spotted excessive use of coordination team meetings and identified some project issues that could have been discussed and decided through an alternative way of communication, reducing the number of meetings.

One tutor referred her difficulty to account the workload related to project coordination tasks. For her "what needs to be answered is: "Is the relation between staff effort and students' results positive?... is it worth it?"

Another tutor suggested that the "use of project tasks to assess PSCs" should be stimulated, and that "PSC teachers are not making it yet… resulting in an heavy workload both for PSC and Project". Another teacher agreed with this conclusion and added that "this is only possible if the PSC are well integrated within the project".

The GQ teacher spotted "many moments of heavy workload within IME PLE", but also "…assessment is readily done..." therefore valuing the new assessment model instead of traditional teaching, where assessment through written exams tends to be more spread over time.

3.2 Project theme and content integration

As said before, the selection of the project's theme is based on its pertinence and importance but, also, on its adequacy to PSC contents, especially GC. So, it is more or less expected that courses like CC had some difficulties in integrating the theme selected in the contents prepared for the semester. This was perceived by the coordination team members, in particular, IIE teacher referred "When we think about the Project theme, we think how we integrate GC and IIE and we do not think how we integrate CC, then the difficulties with integration arise."

This requires a continuous effort try to involve and readjust all program contents as one of the tutors noticed "Need to readjust the program contents: understand the project and look for the best possible way to integrate contents, even changing the syllabus or the contents order. It is a fundamental effort of the teachers. But this is a

difficult task, mainly when the teachers involved weren't responsible for the CU, like the NSC teacher (IME PLE observer), who admitted that "Initially I thought that I couldn't integrate the biggest part of the IEE contents but now, after what I have seen, I think I could." However, for this teacher it is difficult adapt the curriculum contents to the project: "I can't reformulate the syllabus contents, I can't teach *Costs*".

IIE teacher referred that these difficulties arose because the first year IME PLE didn't have an Integrated Project course. He says "We need one thing and the courses give another. An Integrated Project course is missing in the first year and I am increasingly convinced of that."

Other IIE teacher concludes that it is important to direct the project more "I think we have to define some concrete things in regard to the project. It could facilitate the content application. However, this change might put in risk one of the main characteristics of the project – be open."

3.3 Learning outcomes and the PLE methodology

The discussion involving students' learning process and outcomes in PLE is already a common theme amongst the coordination team meetings. However, in the 2008/09 PLE edition, one of the new participants in PLE processes, a teacher who played the single role of a tutor during the semester, expressed that her expectations in regard to students learning outcomes and the PLE methodology itself, hadn't changed. She believes that PLE brings some disadvantages for first year students "as they arrive to the University and have PLE right in the first semester, so they assume that University is this. They think that they will always work in teams and everything will be easy, that they don't have to get involved in the courses and that they will always get their way through by sticking to their teammates". She also referred that, in her opinion, "students seem not to get the message behind PLE" because, as she lectures these students later, in a course which takes place in the second semester, and verifies that "students seem not to be capable of transferring the knowledge and skills developed earlier, during PLE, to other different contexts. For instance, they should already know how to make a written report and I don't see them doing that successfully when I ask them to make one, for my course".

This point of view, however, was not shared by most of the coordination team members in the meeting. Many arguments and specific examples were given by other teachers and tutors, present at the meeting, in order to clarify that what actually might be happening in the second semester does not have necessarily to be related with PLE or even a consequence of its implementation. The coordinator of the semester stated that "when students reach the second semester, they become more relaxed. They are used to being under great pressure and, suddenly, they find themselves in a learning process which is less demanding, so they kind of sit back." Another teacher reinforced this idea saying that "it was the effect of worn-out."

Other teachers pointed out the positive outcomes which have been demonstrated by PLE students in previous years. The NSC teacher (IME PLE observer) was surprised by the quality of students' written reports and oral presentations. She said "I was quite amazed by their level of their autonomy during the discussion with the rest of the class." Besides this, one of the IIE teachers also called the attention for the opinion of some senior students, from the fifth year of IME, in regard to PLE students' performance, as he stated that "they were completely surprised by the quality of the presentations of first year students. They remembered their own first year at the university and they recognised that they didn´t make such outstanding presentations or master the courses contents with such a grasp as these students did."

3.4 Improvement changes

Coordination team members were also asked to propose improvement changes. Based on their fundamental reflections, a few items were identified. These items are presented and cross linked with domains of analysis in Table 5.

Staff workload reduction could be based on 4 items from this list. Item 1, reducing the number of staff meetings would, undoubtedly, contribute to this reduction. Considering the total number of meetings and the comparison with other PLE approaches, it was found possible to accomplish this goal without reduction of project results. Furthermore, as described by Alves *et al.* (2009), this reduction could also result from a lower number of attendees in each meeting.

Item 4 could contribute to the change of focus of assessment procedures. In case of implementation of this change proposal, courses' continuous assessment should be based mainly on project tasks instead of specific content assessment through tests. This should be bounded to a reduction on the number of continuous assessment tests (item 5) to maintain a balanced workload for students.

The reduction of the number of project reports is a consensus change (item 7). This should be replaced with something simpler like, for instance, the presentation of an argumentative strategy to sell the main project idea of the student's team.

Investing more time on the design and planning of the project, as well as identifying more detailed course requirements for each project phase (items 2 and 10) could facilitate the selection of the most appropriate project theme, as the interdisciplinarity between courses' contents could be explored more deeply between lecturers. This could result in more clear objectives and more adequate plans.

A clear interpretation from this list of items is the special focus on student learning and methodology improvement. Besides the positive results achieved by this project approach, in regard to student learning and competencies developed, the team of teachers is motivated to propose a few improvement changes. Most of the proposals are directly related to assessment and deliverables (items 3, 4, 5, 7, 8). It is a general perception from this team that learning is strongly influenced by deliverables and assessment activities. So, an improvement on the number and type of assessment elements could make a strong contribution for the improvement of student learning. Furthermore, some members of this team also believe that project requirements should be more detailed and clearer (item 10), which together with a better comprehension (item 6) of the project approach will be a benefit for students results. Finally, an increased level of interdisciplinarity is expected from the inclusion of the only NSC (item 9).

Table 5: List of improvement changes and relation with domains of analysis.

Improvement Changes		Staff Workload	Theme & Interdisciplinarity	Learning & PLE
1.	Reducing the number of staff meetings	X		
2.	Investing more time in planning		X	
3.	Consider project milestones deliverables as elements of course's evaluation	X	X	X
4.	Each curriculum unit should reduce one test	X		X
5.	Students should make a better use of feedback			X
6.	Each students' team should get a print copy of the Project Guide			X
7.	One report less	X		X
8.	Anticipate the first version of the final report			X
9.	NSC included in the project.			X
10.	Identify detailed course requirements for each project phase		X	X

It should be noticed that some of these suggestions can have a less positive effect on other domains. For example, investing more time in planning, preparing the theme and related contents can increase the teachers' workload. So, it is necessary to find ways of implementing these proposals that do not put in risk other aspects of PLE approach. For instance, in item 5 – students should make a better use of feedback – the students' teams can deliver a short essay indicating that the changes proposed by staff were included in the report. This essay should be designed in such a way that it would not be necessary for staff to read most of the report again.

4 Conclusion

This Project approach is continuously under evaluation aiming to monitor students learning progress. In the project edition described in this paper, the analysis of feedback from the coordination team resulted in the identification of a set of dimensions in regard to the constraints or doubts faced throughout the process. These dimensions include: staff workload, project theme and content integration, learning outcomes and the PLE methodology. For all these dimensions were presented improvement changes. Additionally, it is clear that the complexity of the organization model of PLE process is due to the several stakeholders and different courses which are involved. A strong level of coordination must be fostered amongst faculty staff in order to consider each of the views, interests and expectations of members involved in the process.

The proposals presented by the staff team will be considered in the beginning of the year 2009/10. On the first meeting of the staff team, issues related to the PLE process should be reviewed such as: How many meetings will we need to have? What are the alternatives in order to solve problems, without necessarily having to do a formal meeting? During the selection of the project theme, what is the role of each curricular unit in the project? At what time in the process project? What are the milestones that we have to change in the planning (one report less, one test less for each curriculum unit)?

In fact, it's also important to clarify the mission and goals of the PLE methodology with students. This could be assured by the tutor of each student team. Furthermore, it is important to find mechanisms which ensure that students and teams make a better use of feedback given.

The implementation of these improvement changes can result in other constraints or doubts to the PLE process. However, it is important make a critical analysis about the IME PLE process because it allows the establishment of action plans, essential for the achievement of better results.

References

Alves, A., Moreira, F., Sousa, R. M., & Lima, R. M. (2009, 15-17 May 2009). *Teachers' workload in a project-led engineering education approach (in press).* Paper presented at the International Symposium on Innovation and Assessment of Engineering Curricula., Valladollid, Spain.

de Graaff, E.& Kolmos, A. (2003). Characteristics of Problem–Based Learning. *International Journal of Engineering Education*. Vol 17, No.5.

Helle, L., Tynjälä, P., & Olkinuora, E. (2006). Project-based learning in post-secondary education - theory, practice and rubber sling shots. *Higher Education,* 51:2, 287-314.

Mills, J. & Treagust, D. (2003). Engineering Education – is problem-based or project-based learning the answer? *Australasian Journal of Engineering Education*. Available online at http://www.aaee.com.au/journal/2003/mills_treagust03.pdf

Powell, P. C., & Weenk, W. (2003). *Project-led engineering education*. Utrecht: Lemma.

Van den Kroonenberg, H. H. & Siers, J. (1992). *Methodisch Ontwerpen* [Methodical Design]. Culemborg: Educaboek.